No. 4,786,799, to render obvious the subject matter of Claims 12 and 13. During the interviews, however, Applicant's attorney explained in considerable depth that the disclosure of Schilling et al. clearly *precludes* the conclusion that any claim of the application could have been anticipated by the prior art, or could have been obvious thereover to one of ordinary skill in the art.

The Examiner's attention was directed primarily to the provisions of Claim 1 by which the characteristics of the claimed assembly, operating at a selected full power condition, are defined; i.e., the provisions recited beginning at line 13 of Claim 1 ("... wherein the assembly is further adapted ..."). It was emphasized that under such conditions the "second" cyclic energy controller energizes the "second" heating element at substantially maximum duty cycle, so as to provide a substantially maximum power in the "second" heating zone, while the "first" cyclic energy controller energizes the "first" heating element at less than maximum duty cycle, so as to provide less than maximum power in the "first" heating zone.

Those operating conditions could not possibly occur in an electric heating unit that is constructed in accordance with the teaching of Schilling et al. The reason for that is most concisely stated at lines 51 through 53 in column 6 of the patent:

> The control is provided in such a way that either or both the relays 23, 24 are closed for the flow of current, or alternatively one relay is closed and the other open ...

Obviously, this teaching precludes the full power mode of operation required by Claim 1 of the instant application, wherein one heating element is energized at substantially maximum duty cycle while and the other is energized at less than maximum duty cycle. In accordance with Schilling et al., only two conditions are possible: either both relays are continuously

closed for the flow of current, thus providing the maximum duty cycle in each, or the relays operate so that when one of them is open the other is closed (and vice versa) so as to alternatingly switch the current between the corresponding heater elements, thereby providing the maximum duty cycle to neither. That is, according to Schilling et al. either both heaters operate at full power -- or neither does.

During the telephone conversations held, the Examiner expressed some uncertainty about the application of the "duty cycle" concept to the present invention. Indeed, he asked for a specific example to illustrate that feature; the accompanying evidence and the following discussion are provided in response.

Attention is invited to the appended waveform diagram, which shows cycles of electrical energy supplied to various heaters, and graphically illustrates the fundamental differences that exist between the Schilling et al. disclosure and the present invention.[1]

As discussed above, Schilling et al. disclose two operating modes; i.e., a full power mode, in which each heater is energized at full maximum duty cycle, and a lower power mode in which the cycles are *shared* between the two heaters, with each heater necessarily being energized at less than maximum duty cycle. The full power mode is shown in the top two illustrations (waveforms A and B) and the lower power mode is shown in the middle two illustrations (waveforms C and D).

The full power mode illustration (waveforms A and B) is based on the description at column 6, lines 51-52 of Schilling et al., according to which both relays are closed for the flow of current throughout the full eight-wave period depicted. The lower power mode

[1] For the avoidance of doubt, Applicant emphasizes that this diagram being provided for illustrative purposes only, and is *not* being presented for entry as a figure of the specification.

(waveforms C and D) is based on Figure 2 of the patent and the description at column 6, lines 53-56, according to which one relay is closed when the other relay is open and, on switching, the opening or closing (as the case may be) of one relay takes place at the same time as the closing or opening of the other; i.e., each relay is closed for the delivery of only four waves of current during the eight-wave period depicted.

It follows that in waveforms A and B full power (i.e., maximum, or 100 percent duty cycle) is supplied to both heaters 3 and 4 whereas, in waveforms C and D, the power supply is divided between the two heaters 3 and 4, each heater being energized in turn (i.e., sequentially) so as to operate at 50 percent duty cycle in the example depicted by the appended illustration. Certainly, the ratio can vary from the 50:50 split shown in the illustration, but it remains true that if both heaters are not constantly energized together (i.e., simultaneously), in accordance with Schilling et al., then the two heaters must be energized sequentially.

The lower two illustrations of the appended diagram (waveforms E and F), taken together, depict a full power mode of cyclic operation in accordance with the present application, as set forth in Claim 1 and (for illustrative purposes only) specifically defined by Claim 10. It should be appreciated that, in the particular case of waveforms E and F the full period consists of ten waves (to embody Claim 10) rather than eight, and that the illustration is foreshortened; i.e., in practice there would be a further wave passed and then a full wave blocked, giving a repeating pattern of four waves being passed followed by one wave being blocked.

More particularly, the outer heating element 22 (in Figure 1 of the application) is energized at maximum (or 100 percent) duty cycle; that is, all ten waves of electrical current

are supplied to the heating element 22, as shown in waveform F. At the same time, however, the inner heating element 20 (in Figure 1) is operated at less than maximum duty cycle, and specifically at an 80% duty cycle, as shown in waveform E; that is, eight of the ten waves that occur during the illustrative period (i.e., the first four of the first group of five, and the first four of the second group of five) are supplied to the heater 20, while the fifth (as shown) and tenth (not shown) are being blocked.

Thus, the crux of the claimed invention lies in the combination of maximum duty cycle for one heating element and a step down in duty cycle for the other heating element, when the two elements are energized together in a selected full power operating condition of the assembly.

As the Examiner appreciates, duty cycle control is itself well known, and the technique of blocking cycles is a fundamental aspect of such control. For further edification, however, a copy of a Wikipedia definition of duty cycle (which was read in part to the Examiner during the interviews) is enclosed.

In the context of the present invention, the duty cycle of energization of a heating element represents that portion of the cycles of AC electric current that is passed to a heating element, out of the total number of cycles produced during a given time period. Taken in that context, Figure 2 of Schilling et al. shows and describes a 40:60 duty cycle ratio for the heaters 3 and 4, in that one heater receives 8 full waves of power out of each 20-wave period and the other heater receives 12 full waves during the same period; neither heater receives all 20 energy waves during the illustrative period. The disclosure at lines 39-44 in column 2 of the patent describes a variation in which 5 full waves out of each 20-wave period are di-

rected to one heater, with 15 full waves being directed to the other heater. The heater that receives 5 full waves during each 20-wave period is of course operating at a 25 percent duty cycle, and the heater that receives 15 full waves out of each 20 full waves is operating at 75 percent duty cycle; Schilling et al. state that this "corresponds to a power distribution of 25 to 75%" (column 2, lines 43-44). Here again, however, neither heater receives a full 20-wave power supply.

It should be appreciated that the concept of a duty cycle is somewhat restricted in Schilling et al., because the reference is concerned with the distribution of duty cycles. In more general terms, a proportion of cycles to a single heater can be blocked to determine the duty cycle of that heater.

Finally, during the telephone interviews the Examiner questioned the meaning of the phrase "operable together," as used for example in line 14 of Claim 1 (in the form of the claim last presented). The phrase would certainly be understood by one of ordinary skill in the art to mean that the heating elements are *simultaneously* energized (albeit at different duty cycles in the full power mode). Thus, as depicted in the attached diagram, waveforms E and F show that the two heating elements 20 and 22 must operate simultaneously.

Moreover, and as is clearly distinct from Schilling et al., during operation of Applicant's assembly in its full power mode *some overlap must occur* in the energization of the two heating elements during each period. This distinction is readily seen in the graphic illustration provided.

In view of the foregoing, it is respectfully submitted to be evident that the claimed invention is neither anticipated by, nor would it have been obvious over, the prior art. Pas-

sage of the application to allowance is believed to be clearly in order, and such action is earnestly solicited.

Respectfully submitted,
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CERTIFICATE OF MAILING

I, IRA S. DORMAN, hereby certify that this correspondence is being deposited with the United States Postal Service, postage prepaid, in an envelope addressed as set forth on the first page hereof, on July 27, 2006.

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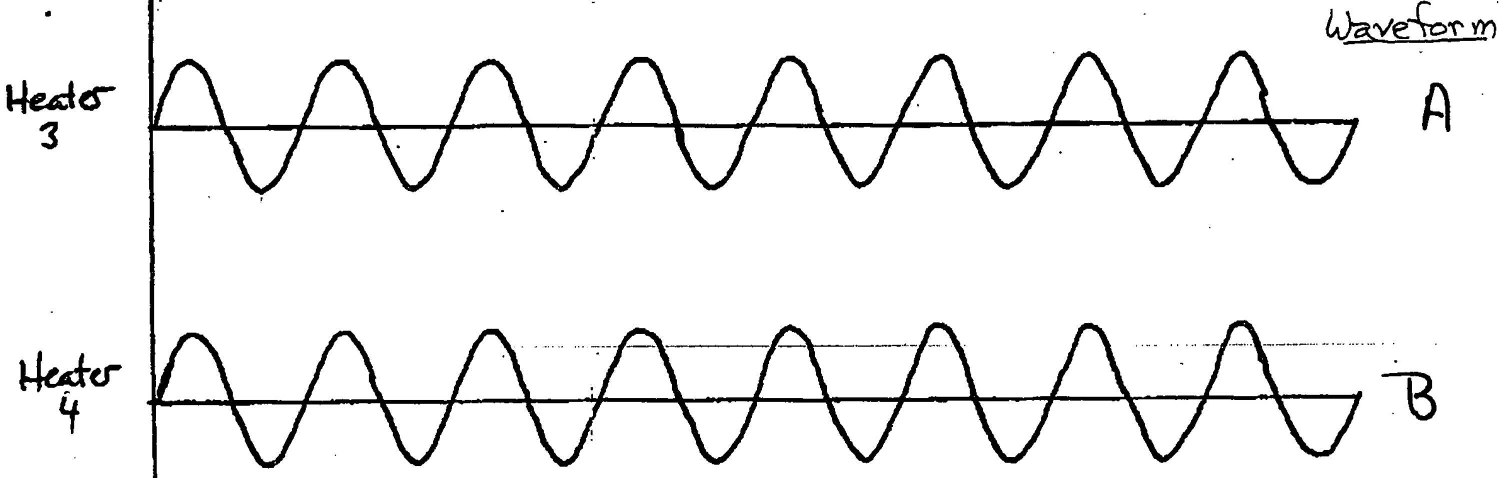
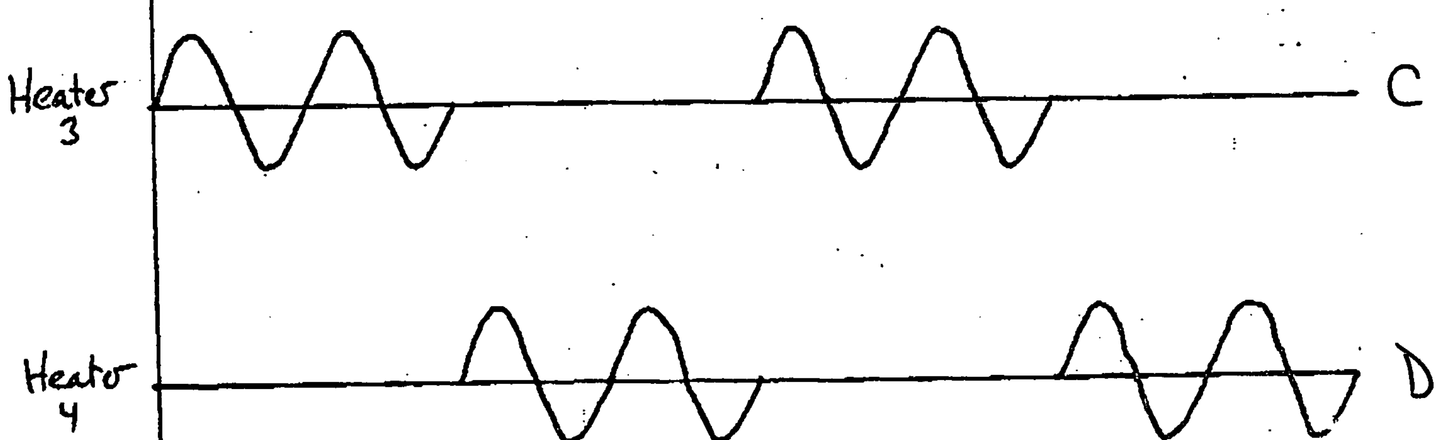
cc: Derek C. Jackson, Esq.
(Ref. No. P0697)

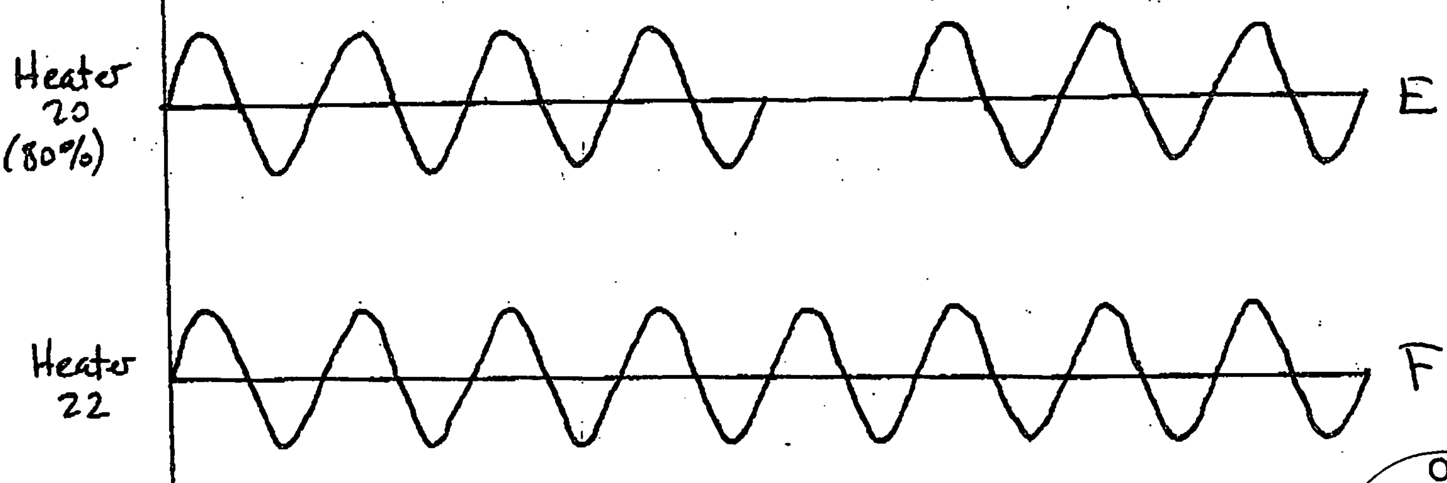
Schilling et al - Full Power



Schilling et al - Less than Full Power (Fig. 2)



Present application - Full Power (as claimed)



Duty cycle

From Wikipedia, the free encyclopedia

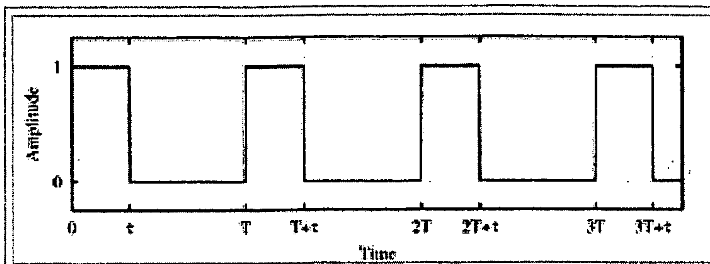
In telecommunication and electronics, the term **duty cycle** has the following meanings:

- In a periodic phenomenon, the ratio of the duration of the phenomenon in a given period to the period.

  duty cycle $D = \frac{\tau}{T}$

where

D is the so-called duty cycle;
τ is the duration that the function is non-zero;
T is the period of the function.



The duty cycle D is defined as the ratio between the pulse duration and the period (T) of a rectangular waveform

For example, in an ideal pulse train (one having rectangular pulses), the duty cycle is the pulse duration divided by the pulse period. For a pulse train in which the pulse duration is 1 μs and the pulse period is 4 μs, the duty cycle is 0.25.

For another example, for a piece of electrical equipment, like an electric motor, the period for which it may be operated without deleterious effects, such as from overheating.

- The ratio of (a) the sum of all pulse durations during a specified period of continuous operation to (b) the total specified period of operation.

- In a continuously variable slope delta (CVSD) modulation converter, the mean proportion of binary "1" digits at the converter output in which each "1" indicates a run of a specified number of consecutive bits of the same polarity in the digital output signal.

Pulse-width modulation (PWM) is used in some music synthesizers to vary the duty-cycle of an oscillator during the performance, which has a subtle effect on the tone colors obtained.

This article contains material from the Federal Standard 1037C (in support of MIL-STD-188), which, as a work of the United States Government, is in the public domain.

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